

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/EP04/053672

International filing date: 22 December 2004 (22.12.2004)

Document type: Certified copy of priority document

Document details: Country/Office: EP
Number: 03104971.1
Filing date: 24 December 2003 (24.12.2003)

Date of receipt at the International Bureau: 09 March 2005 (09.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

Bescheinigung

Certificate

Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

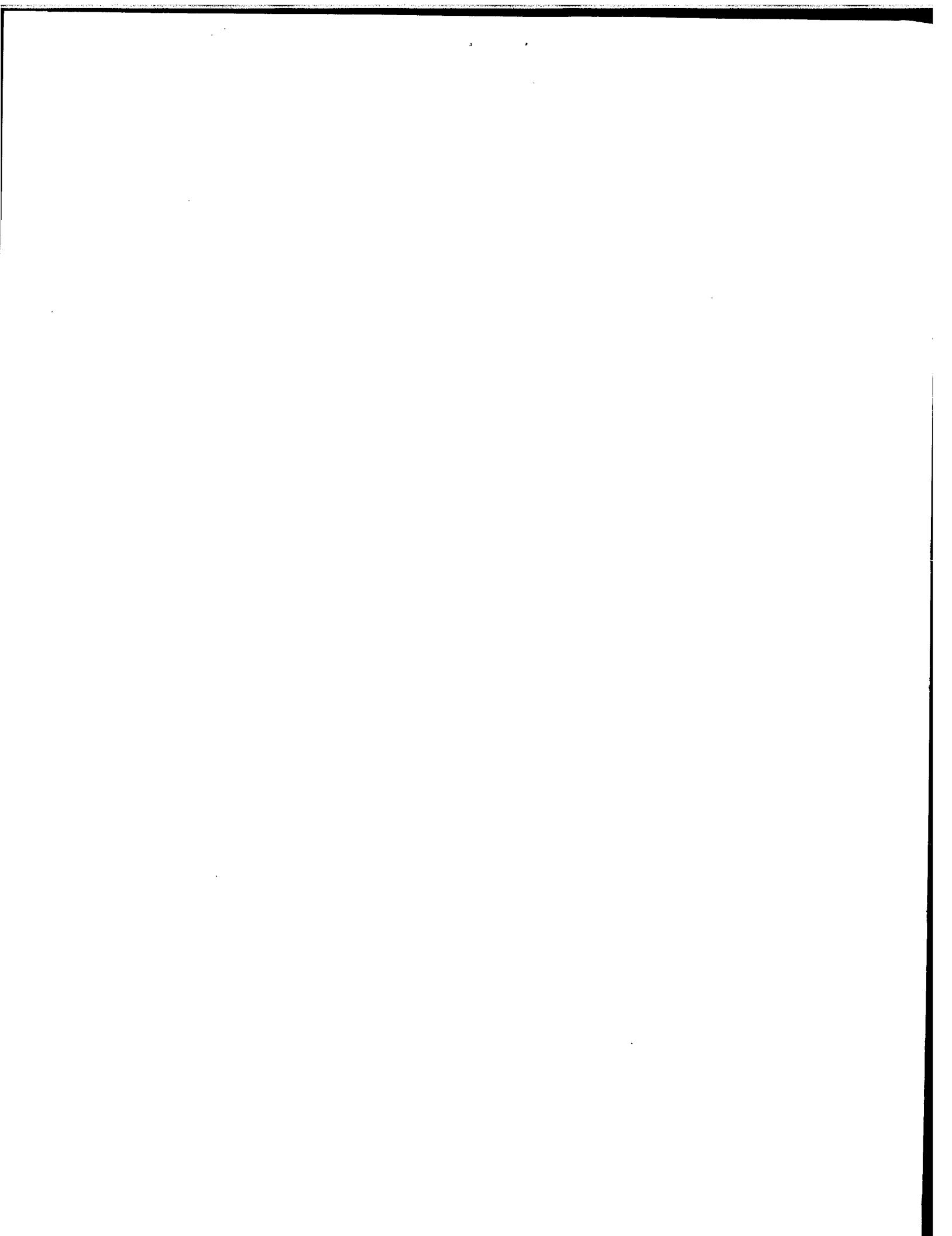
Patentanmeldung Nr. Patent application No. Demande de brevet n°

03104971.1

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office
Le Président de l'Office européen des brevets
p.o.

R C van Dijk





Anmeldung Nr:
Application no.: 03104971.1
Demande no:

Anmeldetag:
Date of filing: 24.12.03
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

SHELL INTERNATIONALE RESEARCH
MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
2596 HR Den Haag
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

DOWNHOLE FLOW MEASUREMENT IN A WELL

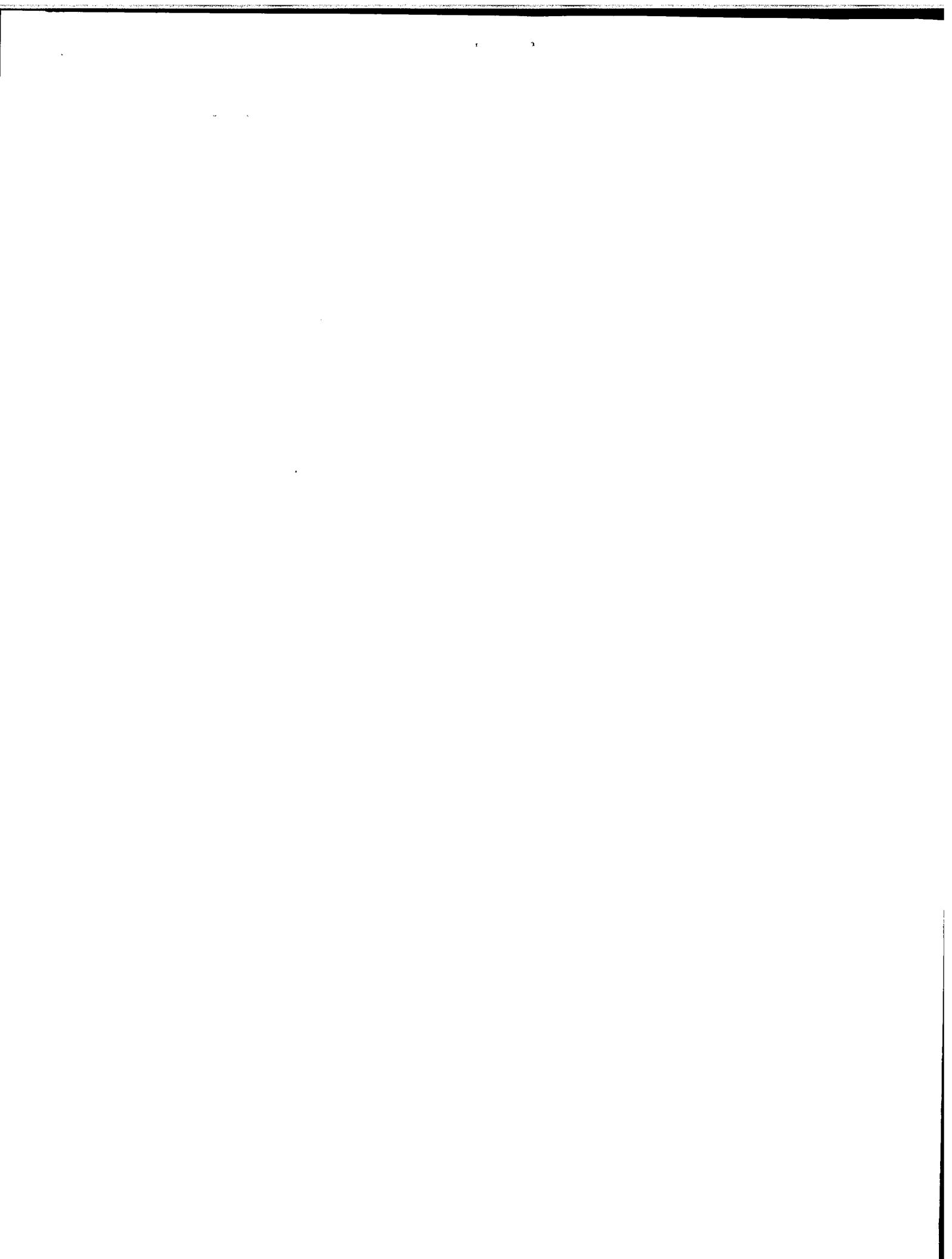
In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s)
revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

E21B47/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of
filing/Etats contractants désignés lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT RO SE SI SK TR LI



DOWNHOLE FLOW MEASUREMENT IN A WELL

BACKGROUND OF THE INVENTION

The invention relates to a method for downhole flow measurement in a well.

Such a method is known from International patent application WO 01/75403. In the known method one or more cold spots are created in a well tubing by injecting nitrogen into the well and expanding the nitrogen at selected downhole cooling stations.

A fibre optical cable extends in longitudinal direction through the well and is configured as a distributed temperature sensor ("DTS"), wherein one or more light pulses are transmitted through the fibre optical cable and the temperature pattern along the length of the cable is determined on the basis of determination of the intensity of Raman peaks in the backscattered optical signal. In a DTS system the time of flight of the backscattered signal is used to determine the location from where the signal is backscattered in a manner similar to the operation of a radar system.

In the known method the DTS system measures the speed at which the cold spot imposed at each cooling station migrates in downstream direction through the production tubing.

A disadvantage of the known method is that the installation of one or more cooling stations and a nitrogen or other cooling fluid supply line in a well is expensive and fragile and thus prone to damage.

It is an object of the present invention to provide a method of downhole flow measurement in a well, which does not require the installation of one or more cooling stations and fragile cooling fluid supply conduits downhole in the well.

5

It is a further object of the invention to provide a method for measuring the influx of fluids into the well along at least part of an inflow region along which fluids flow from the surrounding formation into the well.

10 SUMMARY OF THE INVENTION

The method according to the invention for downhole flow measurement in a well comprises installing a fibre optical distributed temperature sensor (DTS) system along at least part of the length of an inflow region of the well and using the sensor to measure one or more fluctuations of the temperature of fluids flowing from the formation into the well and the velocity at which at least one of said natural fluctuations migrates in downstream direction through the well.

15 It has surprisingly been found that there are fluctuations of the temperature of the fluids that flow into the well, which fluctuations generally die out before the produced fluids have reached the wellhead. The temperature fluctuations are generally small and may be less than 1 Degree Celsius.

20 Accordingly it is preferred that the DTS system is configured to track the downstream migration through the well of low frequency temperature fluctuations of less than 1 Degree Celsius, typically fluctuations between 0.1 and 0.5 Degrees Celsius.

25 It is also preferred that the DTS system extends along at least a substantial part of the length of an inflow region of the well and that the method is used to

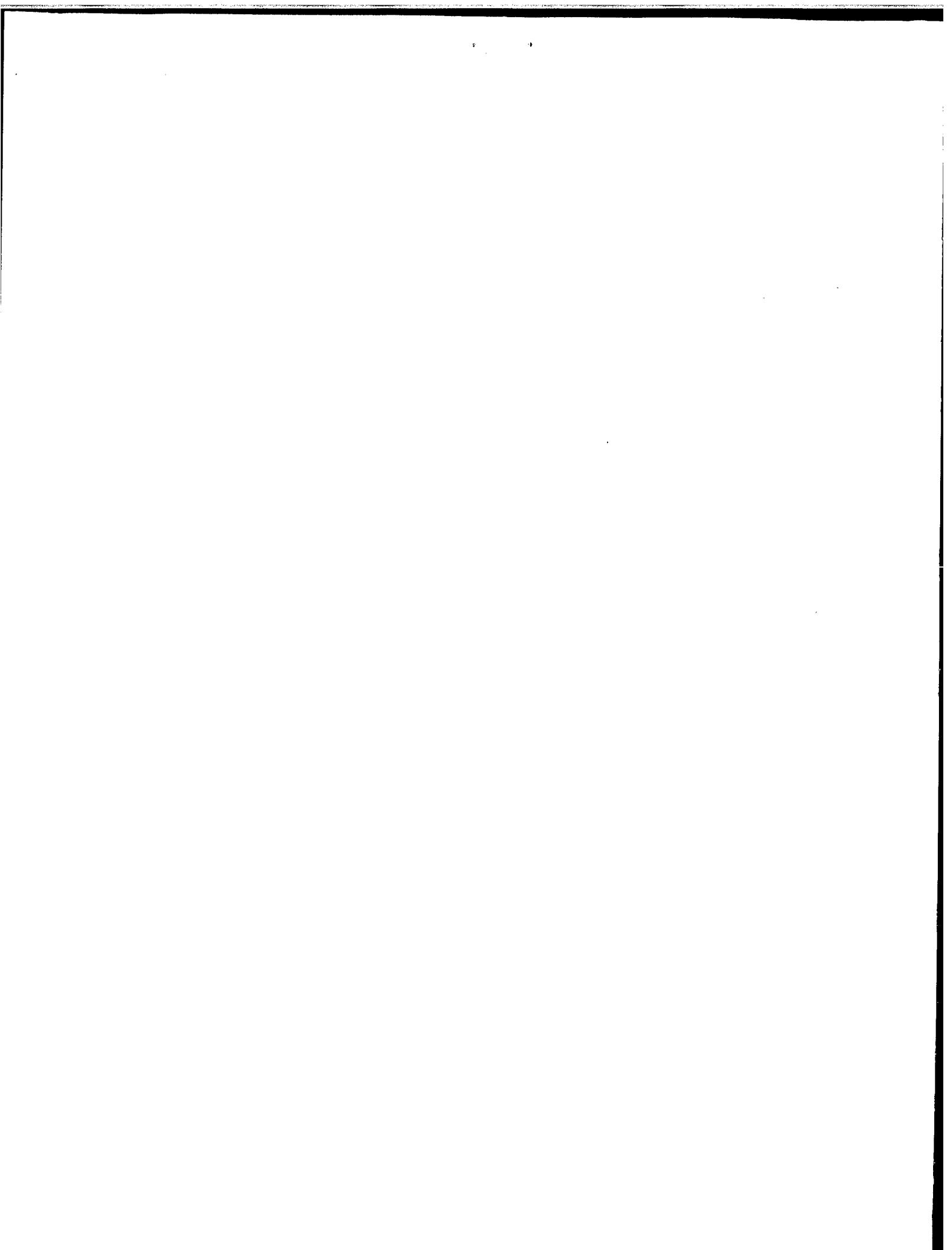
30

assess the fluid inflow rate at different locations along
the length of the inflow region on the basis of measured
variations of the velocity of the fluids in a
longitudinal direction along at least part of the length
5 of said inflow region. A stationary flowrate of fluids in
downstream direction along a DTS measurement interval
will generally indicate that no fluid flows into the
measurement interval, whereas an increased flowrate in
downstream direction along a DTS measurement interval
10 will generally indicate that fluids flow from the
formation into the well along the length of the
measurement interval.

The method according to the invention may be applied
to monitor the fluid flow rate and inflow rate downhole
15 in a hydrocarbon fluid production well.

The fluids flowing into the well may comprise gaseous
components, such as natural gas, and/or components which
at least partly evaporate in the inflow region. In such
case the fluid production rate of the well may be
20 cyclically varied over time to impose temperature
fluctuations caused by variation of the expansion and/or
evaporation rate of the gaseous and/or evaporating
fluids. In such case the fluid production rate of the
well may be cyclically varied by cyclic variation of the
25 opening of a production choke or downhole valve or by
initiating a slug flow regime in the well or in the
production flowline and/or processing equipment
downstream of the wellhead.

These and other features, embodiments and advantages
30 of the downhole flow monitoring method according to the
invention are described in the accompanying claims and
abstract.



C L A I M S

1. A method for downhole flow measurement in a well, the method comprising installing a fibre optical distributed temperature sensor (DTS) system along at least part of the length of an inflow region of the well and using the
5 sensor to measure one or more fluctuations of the temperature of fluids flowing from the formation into the well and the velocity at which at least one of said natural fluctuations migrates in downstream direction through the well.
- 10 2. The method of claim 1, wherein the DTS system is configured to track the downstream migration through the well of low frequency temperature fluctuations of less than 1 Degree Celsius.
- 15 3. The method of claim 2, wherein the DTS system is configured to track the downstream migration through the well of natural low frequency temperature variations between 0.1 and 0.5 Degrees Celsius.
- 20 4. The method of claim 1, wherein the DTS system extends along at least a substantial part of the length of an inflow region of the well and the method is used to assess the fluid inflow rate at different locations along the length of the inflow region on the basis of measured variations of the velocity of the fluids in a longitudinal direction along at least part of the length
25 of said inflow region.
5. The method of any preceding claim, wherein the well is a hydrocarbon fluid production well.
6. The method of any preceeding claim, wherein the fluids flowing into the well comprise gaseous components

and or components which at least partly evaporate in the inflow region and the fluid production rate of the well is cyclically varied over time.

- 5 7. The method of claim 6, wherein the fluid production rate of the well is cyclically varied by cyclic variation of the opening of a production choke or downhole valve or by initiating a slug flow regime in the well or in the production flowline and/or processing equipment downstream of the wellhead.

A B S T R A C T

DOWNHOLE FLOW MEASUREMENT IN A WELL

A method for downhole flow measurement comprises installing a fibre optical distributed temperature sensor (DTS) system along at least part of the length of an inflow region of the well and using the sensor to measure fluctuations of the temperature of fluids flowing from the formation into the well and the velocity at which said natural fluctuations migrate in downstream direction through the well. The measured temperature variations may be low frequency temperature fluctuations of between 0.1 and 0.5 Degrees Celsius, which gradually die out downstream of the inflow region(s) of the well.

